

Teaching Mixed-Signal Characterization with Low-Cost Tester

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The Challenge: Creating a low-cost virtual instrumentation tool for teaching mixed-signal integrated circuit characterization concepts. The tester must have the analog-to-digital and digital-to-analog converter functionality needed for students to properly learn mixed-signal testing techniques, but must be affordable enough for use in academic institutions.

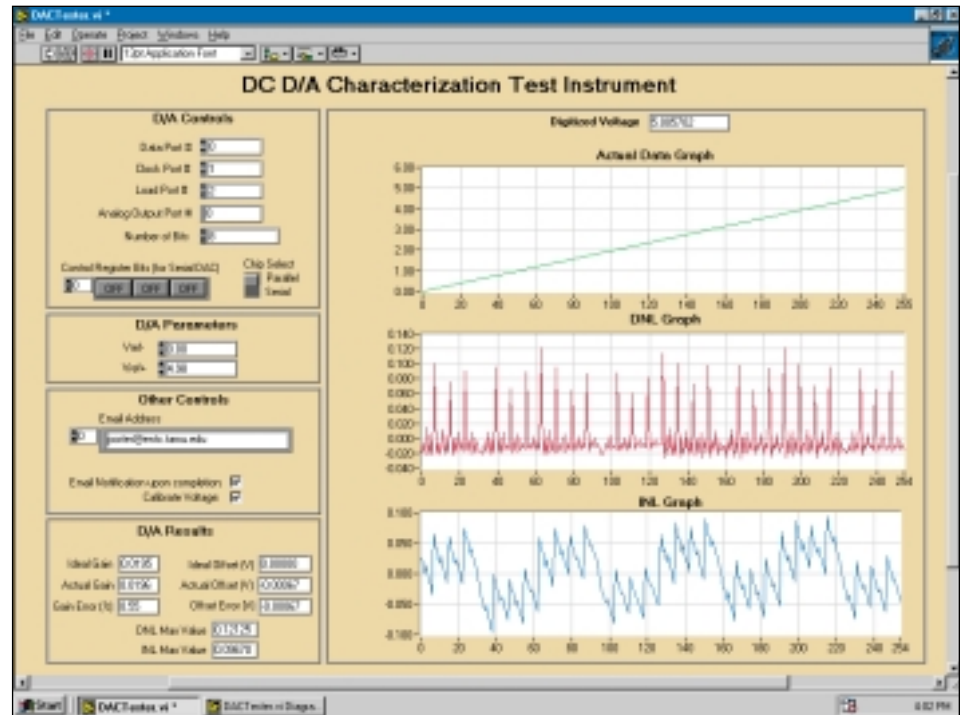
The Solution: Using LabVIEW in conjunction with a high-speed digital I/O card, a multifunction DAQ card, and GPIB-interfaced test and measurement equipment, we created a powerful yet low-cost virtual instrumentation tester for teaching mixed-signal characterization.

Using LabVIEW and DAQ for Tester

Characterizing mixed-signal integrated circuits typically requires extremely high-end test equipment, ranging in cost from fifty-thousand to several million U.S. dollars. While such equipment is available, it is too expensive for the typical academic laboratory. Using electronic lab equipment, National Instruments DAQ cards and LabVIEW, we have implemented a low-cost tester capable of demonstrating analog-to-digital (A/D) and digital-to-analog (D/A) converter testing in an academic environment. We designed the tester to be modular, so that students can “mix and match” virtual instrumentation components and design their own test systems.

Creating a Flexible, Low-Cost Tester

Using National Instruments LabVIEW, a multifunction data acquisition PCI card, and a high-speed digital I/O PCI card, we created a low-cost mixed-signal characterization tester to test 8-bit mixed signal devices. The tester demonstrates concepts such as:



Front panel of a digital-to-analog DC characterization test

- D/A and A/D converter characterization
- Equipment selection
- Focused calibration concepts
- Noise issues
- Sampling rate and coherency issues

By using a National Instruments PCI-DIO-32HS digital I/O card, we developed a digital pattern generator and analyzer for creating, capturing, and analyzing digital signals sent to and read from a device under test (DUT). The card allows the virtual instrumentation software to control registers and produce clock signals needed by a DUT. We can also configure the card for either serial or parallel communication between the software and the DUT. In addition, the four digital ports provide room for later expansion.

Next, by using a PCI MIO-16XE multifunctional DAQ card, the system can

accurately digitize incoming analog signals for D/A testing and produce arbitrary output waveforms for A/D testing. Finally, by adding a GPIB card, we can link the standard bench equipment found in most academic electronics labs for even more flexibility in the control of the DUT environment.

To ensure that the tester is flexible, we designed both the software and hardware to be as modular as possible. Through the use of modular sub-VIs, students can easily mix and match subroutines, creating the ability to quickly design and run any test.

With the hardware of the tester, the student can perform a single test with different types of instrumentation and

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learn appropriate equipment selection. By keeping the hardware modular, the students have more flexibility in deciding how to perform a test and thus learn from trial and error.

One of the shortcomings of the tester is the inaccuracy inherent in low-cost measurement equipment, which fortunately demonstrates a correctable problem we also see on a high-end tester.

Using Low-Cost Tester in Lab

By keeping the functionality of the tester high and the price relatively low, a low-cost virtual instrumentation tester is ideal as the centerpiece for a lab-based mixed signal curriculum. Where a high-production tester

would provide for faster and more accurate testing, the low-cost virtual instrument tester gives the student a hands-on experience of the basics concepts needed to use the high-end testers. Through modular sub-VIs and affordable PCI cards, the virtual instrumentation tester gives the student the experience needed to excel in the area of mixed-signal test.■

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